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MORAL HAZARD, BORROWING, LENDING AND RICARDIAN EQUIVALENCE

Julio J. Rotemberg

Working Paper #1931-87

September 1987

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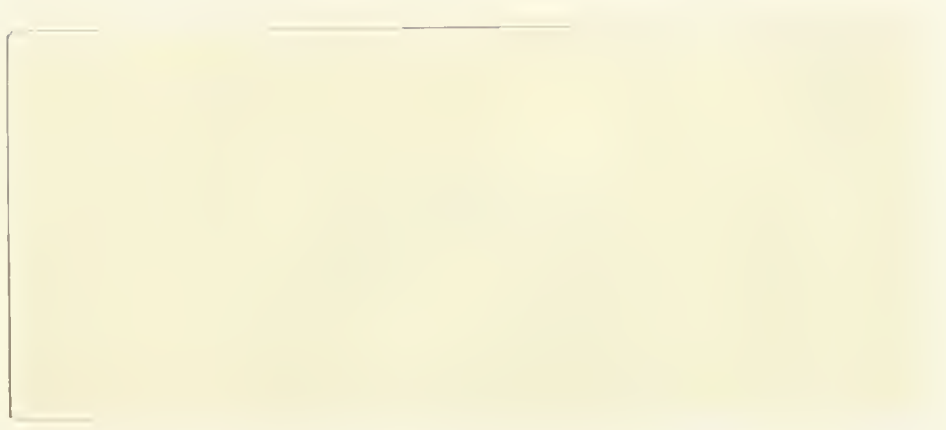

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Abstract

In this paper I study privately optimal contracts when individuals face random payoffs if they expend unobservable effort. Full insurance eliminates the incentive to work so it is generally not optimal. Optimal contracts which tradeoff insurance and the need to preserve incentives are studied. In a simple model I show that these optimal contracts can be implemented using only assets, loans and the institution of bankruptcy. Ricardian equivalence even with with taxes that are a function of income holds locally but not globally in this model. Where Ricardian equivalence fails current tax cuts can easily lead to reductions in current consumption.

* Sloan School of Management, MIT. I wish to thank Olivier Blanchard for discussion and the NSF for financial support.

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The existence of imperfections in financial markets has often been taken to mean that Ricardian equivalence must fail. This a priori argument has lost some of its force since the papers of Hayashi (1986) and Yotzuzuka(1987). They show that the wedge between lending and borrowing rates caused by adverse selection in credit markets does not necessarily imply a failure of Ricardian equivalence. A different failure in financial markets that has been adduced to imply absence of Ricardian equivalence by Barsky, Mankiw and Zeldes (1986) following on work by Chan (1983), is the impossibility, due to moral hazard, of selling human capital. In their models income insurance is not privately provided because an individual who suceeds in purchasing insurance would stop working. Then, government instituted linear income taxes provide some otherwise unavailable insurance which generally affects current consumption.

One weakness of these papers is that they do not consider optimal insurance contracts between individuals, they simply postulate that certain contracts are available and exclude others[1]. In this paper it is shown that in a relatively simple model the existence of optimal contracts, even in the presence of moral hazard, restores Ricardian equivalence locally. While moral hazard prevents full insurance, some insurance is still possible. Small government insurance schemes are then simply offset by changes in this privately provided insurance. Larger social insurance programs have the effect of reducing effort even in the equilibria with optimal contracts. As a result tax cuts accompanied by increases in future taxes that are very progressive (i.e. provide a great deal of insurance) can, by reducing future effort, reduce the individual's permanent income and hence his current consumption.

An objection to this line of analysis is that such privately supplied optimal insurance schemes are simply not observed. The simple example

developed in this paper casts some doubt on this criticism because the optimal contract can be implemented using only the menu of institutions which we observe regularly. In particular, implementation requires only three institutions: it must be possible to borrow, to lend and to go bankrupt. In implementing the optimal contract via these institutions the paper follows the lead of Gale and Hellwig (1985) who show that debt contracts with bankcruptcy can be optimal contracts in a rather different model of asymmetric information. In their model it is the costly observability of income which leads to these contracts.

Implementation via these borrowing, lending and bankcruptcy has some appealing features. First, people will be observed borrowing and lending simultaneously even though interest rates on loans exceed interest rates on assets. It is of course the difference betweeen lending and borrowing rates that is viewed as suggesting liquidity constraints as well as the failure of Ricardian equivalence (Pissarides (1978), Buiter (1985)). Second, individuals will be genuinely credit constrained, they would like to borrow more at the existing lending rate. Not only are they prevented from doing so, no additional borrowing is possible even though the individual is solvent. This is a more strict version of credit constraint than the one shown to hold by Gale and Hellwig (1985) since in their model, as in that of Keeton (1979 ch.2) more would be lent, albeit at higher interest rates.

The paper proceeds as follows. In Section II the model and the optimal contract are presented. Section III is devoted to implementation using assets and liabilities. Section IV discusses Ricardian equivalence in this model while Section V concludes.

II The model

I consider people who live for two periods labeled zero and one. Their utility in the initial period is given by:

$$U(C_o) + \rho EU(C_1) - k\delta \qquad (1)$$

where U is a concave function, C_i is consumption in period i, E takes expectations conditional on information available in the initial period and δ is an indicator variable which takes a value of one if effort is expended and is zero otherwise.

Effort is expended at the beginning of period one. In compensation for the disutility of k, individuals who expend effort earn a high level of income Y_g with probability π. With probability $(1-\pi)$ they are unsuccesfull and they earn the same Income Y_b they would earn without expending effort. These realizations can be thought of as uncorrelated across individuals. As in Holmstrom (1979), effort is unobservable while income and consumption are observable. Individuals also have an endowment W_o in the first period.

A contract specifies transfers between individuals and financial institutions in the initial period, as well as transfers in period one which depend on the realized level of income. Equivalently, and with some gain in convenience, one can view them as specifying three levels of consumption C_o, C_g and C_b which correspond to the initial period and to the two possible levels of income respectively. Effort will be expended if the contract stipulates that:

$$\pi[U(C_g) - U(C_b)] \geq k \qquad (2)$$

while it will not if the inequality is reversed.

Financial intermediaries (which can be thought of as foreigners) are risk neutral and have a dicount factor R. Such risk neutrality emerges naturally if the income uncertainty disappears in the aggregate as in Judd (1985). Thus the intermediaries are willing to sign any contract whose gross rate of return equals R. Therefore, if the probability that income will be high is z, contracts will be offered which satisfy:

$$(W_o - C_o)R = z(C_g - Y_g) + (1-z)(C_b - Y_b) \qquad (3)$$

Optimal contracts maximize (1) subject to (3) and the constraint that effort will be expended (i.e. z equals π) if and only if (2) is satisfied; otherwise z equals zero. I now briefly give a sufficient condition for effort to be expended in any optimal contract (or even in the absence of any contract). This condition which is assumed to hold throughout is:

$$\forall x \geq 0: \ \pi[U(x+Y_g) - U(x+Y_b)] - k > 0 \qquad (4)$$

This condition can be interpreted as follows: Suppose an individual reaches period one with assets equal to x. Then, by expending effort his expected utility changes by the amount on the LHS of (4). I am requiring that this change be positive for all values of x. To see that this implies that optimal contracts involve effort it is sufficient to note that contracts without effort have z equal to zero in (3) so that optimal contracts are simply risk free lending contracts. Hence, if (4) is satisfied, utility can be increased by offering the same size loan and

allowing the individual to keep any extra income that he earns by expending effort.

Given (4) expending effort is optimal. Suppose effort could be costlessly monitored. Expending effort would still be optimal but, since individuals are risk averse and financial intermediaries are risk neutral, consumption would not depend on whether the effort was succesfull. In other words C_g would equal C_b and the individuals would be fully insured. Such full insurance is obviously impossible with unobservable effort; we have the usual tradeoff of incentive compatibility and optimal risk sharing. The optimal contract will achieve as much insurance as is possible given the need to induce effort. It thus will make the constraint (2) hold with equality.

Using (2) and (3) in (1) and differentiating, the optimal contract satifies:

$$U'(C_o)\{1 + \pi[U'(C_b)/U'(C_g) - 1]\} = \rho R U'(C_b) \qquad (5)$$

where primes denote derivatives. Equation (2), (3) and (5) can be solved for the three levels of consumption although that will not be done here.

III Implementing the Optimum with Debts, Assets and Bankcruptcy

Before implementing the equilibrium with debt and assets it is convenient to interpret the optimal contract in more traditional asset-insurance terms. This can be done as follows. The individual can be

thought of as carrying over an amount of risk free assets A equal to (W_o-C_o). Consumption in period one is then:

$$C_g = AR + Y_g + X_g$$
$$C_b = AR + Y_b + X_b$$

where the X's can be though of as transfers. By (3) these transfers represent simply an actuarially fair insurance policy since:

$$\pi X_b + (1-\pi)X_g = 0. \qquad (6)$$

Moreover, since as much insurance is provided as possible and Y_b is relatively low, X_b is positive.

In the debt-assets implementation the individual carries over instead an amount of assets equal to A'such that:

$$A' = A + X_b/R \qquad (7)$$

so that C_b is simply $A'R+Y_b$. Debt obligations D, which are defined as the maximum the person owes to the financial intermediary are equal to:

$$D = X_b - X_g \qquad (8)$$

which is positive by the argument given above. This combinations of assets and liabilities supports the optimal contract as long as bankcruptcy prevents consumption from falling below C_b. Bankruptcy is an institution such that individuals in debt can ask for protection from their creditors,

debts are forgiven as long as the individuals's consumption level is below a certain threshold. This threshold is here required to equal C_b. If the economy consisted of ex-ante identical individuals with uncorrelated payoffs, such a threshold would be have a certain appeal to legislative authorities. If the legislated threshold is different, some other mechanism for forgiving debt to distressed borrowers would have to be implemented.

With bankcruptcy, the debts are forgiven when income is Y_b while they are fully paid when it is Y_g. So the gross return on debts in the event that they are paid must exceed R. Since debts are only paid with probability π, the gross return on debts when they are actually paid must be R/π. This can be seen by noting that since A equals (W_o-C_o), the difference between A' and A must equal the amount the financial intermediary gave the individual in exchange for the claim of D which is payable only in the good state. Moreover, using (6), (7) and (8) it is readily established that $D/(A'-A)$ equals R/π.

If A is positive, the implementation implies an overlap between assets and liabilities of $(A'-A)$. The only reason assets exceed A in period zero is because the financial intermediary has also provided a loan. Such overlaps are commonplace as is evident from table 1 which lists the ratio of the minimum of financial assets and liabilities to the maximum of assets and liabilities for individuals who participated in the Denver Income Maintenance Experiment[2]. Of course, at the optimal contract A need not be positive. A negative A would be a risk free "senior" loan which the intermediary could be sure to collect on even if the individual defaults on his other loans. Even when A is negative, A' can be positive thus leading to an overlap of assets and liabilities although, if A' is negative as well

only liabilities will be observed.

Before one can say that assets and liabilities implement the contract it is necessary to show that if only assets and liabilities were offered, individuals would, in the presence of the appropriate bankcrupcy threshold, select the appropriate levels of assets and liabilities. I deal first with the choice of assets then with that of liabilities.

To find out whether the optimal level of assets would be chosen, I ask whether, starting at the optimal allocation individuals would want to either increase period zero consumption and reduce assets or viceversa. Because of bankcrupcy these two decisions are somewhat different and must be treated separately.

Suppose that an individual decided to increase consumption by one unit in period zero and hold one less unit of A. In the bad state, the intermediary is not collecting anything on its loan so consumption would fall by R. Similarly in the good state the individual is fully paying of his obligation so consumption would fall by R. Thus the change in utility is[3]:

$$U'(C_o) - \rho R[\pi U(C_g)+(1-\pi)U(C_b)] <$$
$$U'(C_o)[1+\pi[U'(C_b)/U'(C_g)-1]\} - \rho R[\pi U(C_g)+(1-\pi)U(C_b)] =$$
$$\rho R\pi[U'(C_g)-U'(C_b)] < 0 \qquad (9)$$

where the first inequality is due to the fact that marginal utility is lower in the good state than in the bad, the equality is obtained using the equation that characterizes optimal contracts (5), and the second inequality is due to the same reason as the first. So this change is strictly bad for the individual. The reason is that for a given increase

in consumption in period zero, optimal contracts provide for a smaller fall in expected utility in period one than do pure asset contracts.

It is worth noting that inequalities such as (9) have been defined as representing liquidity constraints by both Runkle (1987) and Zeldes (1985). Zeldes (1985) finds evidence that for relatively poor individuals this inequality holds strictly while Runkle (1987) using the same PSID data but different methods disputes this conclusion.

Now consider reducing consumption in period zero and raising the level of assets. Since bankcruptcy allows the individual to consume only C_b, the extra assets do not secure increased consumption in the bad state, they do so only in the good state. In that state consumption rises by R. So the change in utility is[4]:

$$-U'(C_o) + \rho\pi RU'(C_g) = \{-\rho U'(C_b) + \pi\rho U'(C_g)[1-\pi(1-U'(C_b)/U'(C_g))]\}/\phi$$
$$= \rho(1-\pi)\{-U'(C_b) + \pi[U'(C_g)-U'(C_b)]\}/\phi < 0$$

(10)

$$\phi = 1 + \pi[U'(C_b)/U'(C_g) - 1]$$

where the first equality is obtained using (5). This change is thus also unatractive. This occurs because extra assets are useless in the bad state where they must be turned over to creditors. Hence, the level of assets required by the optimal contract is the individually rational choice in the strongest possible sense; any deviation makes the individual strictly worse off.

Now consider the choice of liabilities. Changes in period one debts are only relevant if high income is realized since none of the debts are

paid in the bad state. Suppose the individual reduces his consumption in period zero and correspondingly carries fewer debts forward so consumption in the good state of period one is increased by R/π. Using (5), the corresponding change in utility is:

$$-U'(C_o) + \rho RU'(C_g) = \rho(1-\pi)[U'(C_g)-U'(C_b)]/\phi < 0$$

Thus this makes the individual strictly worse off. This means that the individual would like to increase his indebtness by one dollar and consume the proceeds π/R in period zero. Such an increase, however, lowers consumption in the good state without any change in the consumption during the bad state. This means that the inequality (2) will be reversed so that no effort will take place. Thus z falls to zero and all the debts would have to be written off. The intermediary would never accept this. He would impose a strict credit constraint. It is worth noting that the credit constraint is more strict than what has been derived, for instance by Gale and Hellwig (1985) in that additional credit wouldn't be extended at any interest rate. The reason is that if the individual owes even one more dollar in the good state, he stops working and the equilibrium is destroyed.

In conclusion, the implementation of the optimal contract has three empirically relevant features. For individuals, rates of return on assets are lower than those on liabilities. Individuals nonetheless hold both types of instruments. Moreover, individuals would like to borrow more than they are allowed to.

While the implementation of the optimal contract with assets and liabilities appears in some ways natural one caveat is in order. The

implementation of the optimal contract will be more complex when income can take on more values[5]. The main point of this section is that the existence of simultaneous assets and liabilities in the presence of bankcruptcy simplifies the implementation of the optimal contract.

IV Ricardian Equivalence

In this section I consider government tax and transfer schemes which have an expected present discounted value of zero. I allow these transfers to depend on the realization of income so that these transfers can in principle be distortionary. A transfer scheme is thus a triplet (G_o, G_b, G_g) of payments from the government to individuals which satisfy:

$$G_oR + zG_g + (1-z)G_b = 0 \qquad (11)$$

where z is again the probability that high income is earned. Contracts between financial institutions and individuals are entered upon after the G's become known. They still specify the three levels of consumption C_o, C_g and C_b. Now for the financial intermediary to be willing to offer a given contract:

$$(W_o + G_o - C_o)R = z(C_g + G_g - Y_g) + (1-z)(C_b + G_b - Y_b) \qquad (12)$$

which, using, (11) reduces to (3). So intermediaries are willing to offer the same menu of contracts as before. Optimal contracts still maximize (1) subject to (3) and the condition that z is equal to π if and only if (2) is satisfied and is equal to zero otherwise. Thus, if in

equilibrium effort takes place, consumption is unaffected by the government intervention. With government transfers, the condition corresponding to (4) which ensures that effort is expended is:

$$\forall x \geq 0: \ \pi[U(x+Y_g+G_g) - U(x+Y_b+G_b)] - k > 0 \qquad (13)$$

The argument given below (4) ensures that if (13) holds, individuals try to earn Y_g. Moreover, if (4) holds there are exists nonzero government transfers which are such that (13) holds. These transfers can have progressive elements so that, for instance, G_g can be negative while G_b is positive.

Yet, there are also transfer schemes which prevent (13) from holding. In the extreme case in which the transfers schemes are such that (13) holds with the inequality reversed for all x, the only equilibrium has no effort taking place. This can be seen as follows. Suppose that even though (13) holds with the inequality reversed intermdiaries are offering a contract in which effort takes place. This means that (2) holds at least with equality. So, payments from the intermediary to the individual are larger if income is high than if it is low. Suppose that, maintaining (3) a deviating intermediary equalized payments in both states by lowering them in the good state and raising them in the bad. Since $U'(C_g)$ is smaller than $U'(C_b)$ the individual is better off with this contract even if he can somehow be kept working hard. Yet, because (13) holds with the inequality reversed the individual is made even better off by giving up effort. Hence, intermediaries who offer contracts that involve no effort can take all the customers from intermediaries whose contracts require working hard.

Government transfer shemes that eliminate effort have G_g lower than

G_b, they are progressive[6]. So, one form of intervention that can have this effect is a cut in taxes at time zero followed by a small increase in taxes in the event Y_b and a large tax if Y_g is realized instead. If this scheme eliminates effort, lifetime income is lowered so that consumption at time zero falls unambiguously. The tax cut lowers consumption unlike what Barsky, Mankiw and Zeldes regard as the normal case in which the corresponding increase in a progressive income tax raises current consumption because it reduces future consumption uncertainty[7].

V Conclusions

This paper has two foci. One is to show that the simultaneous presence of assets and liabilities together with a certain kind of credit constraint can implement an optimal contract. The other is to show that Ricardian equivalence survives at least locally when markets are incomplete due to moral hazard. One question which arises is whether other models in which failures in the credit market are derived from contracting difficulties can also explain the simultaneous existence of assets and liabilities and whether Ricardian equivalence would survive in these models.

It is worth stressing that reasons for credit rationing advanced by Keeton (1979) and Grossman and Weiss (1981) are not very compatible with the actual contracts that we see. One reason for credit constraints advanced by Jaffee and Russell (1976), Stiglitz and Weiss (1981), Hayashi (1986) and Yotzuzuka (1987) is that different otherwise indistinguishable borrowers have different propensities to go bankrupt. Yet, if insurance contracts were explicitely allowed in this adverse selection model and individuals were risk averse while intermediaries were risk neutral, any equilibrium would include at least some individuals who would be completely insured. In particular, pooling equilibria would have full insurance for everyone while separating equilibria would have full insurance at least for the worst risks.

Another reason for credit constraints advanced by Keeton (1979) and Stiglitz and Weiss (1981) is more related to this paper since moral hazard is involved. They note that as interest rates increase individuals would be tempted to undertake investements with higher risk but with lower

expected return. This induces credit rationing by making rises in interest rates an unprofitable response to excess demand for loans. Yet, when the potential actions of individuals affect the variability of returns the standard debt contract is very unappealing. Instead, to induce people to refrain from adopting needless risk, optimal contracts would specify that individuals be penalized when outcomes which are unusual under more conservative strategies are observed. This is particularly easy for the setup in Stiglitz and Weiss (1987) were the risky and safe project differ only in the probability of the good outcome and in the size of the good outcome. To prevent the risky project from being undertaken it is sufficient to reduce consumption to zero if the good outcome of the risky project is observed.

It may thus be costly observability of income which lies behind the Stiglitz and Weiss (1987) analysis. Gale and Hellwig (1985) show that if income is observable only at a cost, the optimal contract is identical to actual debt contracts with bankruptcy provisions. Their model applies only when the borrower is a risk neutral firm. As a result their model is inconsistent with joint holdings of assets and liabilities. Such joint holdings might well arise, even when the only imperfection is the costly observation of income when borrowers are risk averse individuals.

It may be tempting to conclude that, whatever the market imperfection, if optimal private contracts have the structure of assets and liabilities then changes in taxes which resemble changes in the level of assets and liabilities people carry over can't have an effect. In some sense this paper shows that this intuition is only partially right since Ricardian equivalence does not hold globally. Therefore, whether Ricardian equivalence would carry over into a world in which income is imperfectly

observable is an open question.

It is worth pointing out that Ricardian equivalence holds in this model in part because contracts are signed either after the government institutes balanced budget transfer schemes or because they are made contingent on such transfer schemes. In practice, of course government transfer schemes are instituted after many contracts have been signed and the contracts we observe rarely have clauses that make them contingent on government policy. This incompleteness is reminiscent of the work of Chan (1983) in which randomness is introduced by the government which, for some reason he doesn't explain, is not privately insured.

Yet, in models with simultaneous borrowing and lending there is a natural reason why, when the government acts after private agents have signed contracts, the private sector will not be able to undo the governments action. The reason is that, at least in some sense, agents find themselves at corners since there are credit constraints. So, suppose the government institutes a tax rebate financed by future taxes. If contracts were signed after this program is instituted, individuals would simply be able to borrow less and the scheme would have no effect. If contracts are set in stone by the time the scheme is instituted, indivlduals would continue to avail themselves of the maximum they are allowed to borrow so the allocation would change. The general analysis of the effect on Ricardian equivalence of letting the government act after contracts whlch are not contingent on government actions have been signed is left for further reseach.

FOOTNOTES

1 This criticism applies more generally to most of the literature on credit rationing including Jaffee and Russell (1976), Keeton (1979), Stiglitz and Weiss (1981,1987), Hayashi (1986) and Yotzuzuka (1987). In their models people would like insurance yet only "borrowing" contracts are considered.

2 I am grateful to David Runkle for providing the data on which these computations are based.

3 It is worth noting that reduced assets do not reduce the desire to work. Consumption falls by the same amount in both states so utility falls by more in the low state where marginal utility is high. This means that the difference in utility in the two states actually increases.

4 Again, the increased assets do not impair effort since the increase in consumption when the good state is realized is actually bigger when more assets are carried forth.

5 Such more general optimal contracts are discussed by Varian (1980) who discusses insurance provided by an optimizing government but whose solution corresponds to optimal contracts which are privately supplied.

6 Budget balance dictates that the government note that the scheme will eliminate effort so that G_g becomes immaterial. The low (or negative) transfer G_g never actually takes place.

7 This normal case of course requires that U''' be positive.

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